Chapter 8

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ABSTRACT
The purpose of this chapter is to rectify the at best unprofessional intermingling of objectives and constraints and present a proper theory of first-best and second-best pricing in urban rail networks. First, in view of the flaws of both Dupuit’s – though nevertheless ingenious idea of – consumer surplus as well its cannibalized version found in most of today’s economics textbooks, a proper definition of economic welfare resting on Hicks’ian variations instead is provided. It is used to derive efficient pricing rules that are subsequently applied to specific questions arising from running an urban railway network such as overcrowding, short-run versus long-run capacity or competing modes of transport like the private motor car. At the same time, another look is taken at economic costs, and in particular economic marginal costs, differing from commercial or accounting costs. Among other things, it is shown that even with commercial marginal costs being constant first-best pricing might not necessarily be incompatible with a zero-profit budget.

1. INTRODUCTION
The problem of optimal pricing in transport systems does not just go back right to the beginnings of microeconomics, it actually was the first truly microeconomic question ever asked. The concept of utility is of course older. However, while, e.g., Bentham (1789) discussed the idea of social welfare as the sum of individual utility functions, utility was never used before as an instrument of microeconomics in the sense of individual utility maximisation.

When during the early 1840s the French government turned to Jules Dupuit, an engineer at what today would be called the French Ministry of Transport, and tasked him with devising some system on the basis of which one should be able to decide on whether or not to build a bridge and subsequently which

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toll to charge for its use, microeconomics did not yet exist. One must not forget that Adam Smith, even though talking about equilibria – he called it “natural prices” – and demand and supply, did not visualize demand functions or supply functions, let alone profit maximisation or utility maximisation. Similarly, the only concept of welfare he used just looked at the labour which was required to produce some given aggregate output. Dupuit (1844) subsequently not only conceived the brilliant idea of consumer welfare, but before being able to do that he even had to “invent” the demand curve, or “courbe de consommation”, as he called it, first. The resulting fundamental principle followed pretty straightforwardly. It is the very idea of first-best pricing, it is intuitively appealing, and it is still taught in microeconomics courses at every level all over the world: as long as there are individuals, or users, around who would be willing to pay more than the additional, i.e. marginal, cost that would arise if the good, or service, is to be provided to them, one should go ahead. The optimum quantity then would be the one for which the marginal willingness-to-pay equals the marginal cost. Unfortunately, though, Dupuit’s concept not only rests on the assumption of a cardinal utility function which, at least from a 20th century microeconomic perspective, is somewhat difficult to comprehend. It violates the budget constraint; it breaks down once more than one good is considered due to a possible path dependence of the integral; and once one tries to make it compatible with the budget constraint, the concept would only work for demand functions with an income elasticity of one, i.e. straight-line Engel curves running through the origin.

The purpose of this chapter is two-fold: first, a proper and coherent framework for optimal pricing compatible with modern microeconomic thinking is provided. Formulae for first-best as well as second-best pricing schemes are derived. Second, the formulae are applied to rail networks, paying special attention to budget constraints, the competition between different modes of transport and externalities within and out of the network.

The paper is organised as follows. A summary of Dupuit’s theory of consumer surplus, including its limitations, is presented in section 2. In section 3, a general measure, based solely on the concept of ordinal utility and building on Hicksian compensating and/or equivalent variations, is developed. It is subsequently used to derive a first-best pricing rule which, even though resulting from a completely different technique, turns out to be no different at all from the original result by Dupuit. While this admittedly might look like using the proverbial sledgehammer to crack a nut, the difference shows when turning to second-best pricing where a whole range of new applications, in particular with regard to transport systems, is offered. In section 4, the results are applied to rail transport networks. They include rules how to deal efficiently with budget constraints, short-run capacity constraints and/or externalities both outside of and within a given network. It will be shown that even with constant marginal costs, first-best marginal cost pricing may well be compatible with a subsidy-free budget.

2. DUPUIT’S CONSUMER SURPLUS

The starting point is Dupuit’s idea of utility maximisation: as long as the utility to be gained from consuming one additional unit is greater than its price, the consumer would buy that additional unit. Thus, he would only stop once the two are equal, i.e. marginal utility is equal to the price: with x, p and U denoting quantity, price and utility,